

CLAIMS

What is claimed is:

1. A process of removing H_2S from an H_2S -containing gas stream comprising:
 - forming a reactant gas mixture comprising said H_2S -containing gas and O_2 ;
 - at a temperature greater than the dew point of elemental sulfur, flowing a stream of said reactant gas mixture over a catalyst device in a reaction zone such that the contact time of each portion of reactant gas mixture that contacts said catalyst device is sufficiently brief to allow the reaction $\text{H}_2\text{S} + 1/2 \text{O}_2 \rightarrow 1/x \text{S}_x + \text{H}_2\text{O}$ ($x = 2, 6$ or 8) to occur, whereby a product stream is formed comprising gaseous elemental sulfur and water;
 - passing said product stream into a cooling zone and cooling said product stream to the dewpoint temperature of elemental sulfur, or lower; and
 - recovering elemental sulfur from said cooling zone.
2. The process of claim 1 comprising recovering a desired gaseous product from said product stream.
3. The process of claim 1 wherein said step of flowing a stream of said reactant gas mixture over a catalyst in a reaction zone at a temperature greater than the dew point of elemental sulfur includes keeping the temperature of the catalyst device and/or the reactant gas mixture sufficiently high to deter or prevent sulfur poisoning of said catalyst device.
4. The process of claim 1
 - wherein said step of forming a reactant gas mixture comprises providing a H_2S -containing gas stream comprising up to 100% H_2S , and providing a O_2 -containing gas stream; and
 - wherein said step of flowing a stream of said reactant gas mixture over a catalyst in a reaction zone comprises in a millisecond contact time reactor having a gas mixing zone, a reaction zone capable of withstanding temperatures up to at least $1,500^\circ\text{C}$, and a cooling zone, mixing together said H_2S -containing gas stream and said O_2 -containing gas stream in said mixing zone to form a stream of reactant gas mixture, said reaction zone containing a catalyst device having activity for catalyzing the direct partial oxidation of H_2S to elemental sulfur and water;

maintaining the temperature of said mixing and reaction zones above the dewpoint of sulfur; and forming a product stream comprising gaseous elemental sulfur, and, optionally, a desired gaseous product; and

wherein, said process optionally includes recovering said desired gaseous product.

5. The process of claim 4 comprising maintaining an approximately 2:1 molar ratio of H_2S to O_2 in said reactant gas mixture.
6. The process of claim 4 comprising keeping the temperature of said catalyst device at about 700°C - $1,500^\circ\text{C}$.
7. The process of claim 4 wherein said step of providing a H_2S -containing gas stream comprises providing an H_2S -containing light hydrocarbon stream; and said process further comprises recovering an at least partially desulfurized light hydrocarbon stream.
8. The process of claim 4 wherein said step of providing a H_2S -containing gas stream comprises providing an $\text{H}_2/\text{H}_2\text{S}$ -containing gas stream; and said process further comprises recovering an at least partially desulfurized H_2 stream.
9. The process of claim 4 comprising initially heating said catalyst device to at least about 700°C while passing said reactant gas mixture over said catalyst device until said reaction is initiated.
10. The process of claim 9 comprising maintaining reaction promoting conditions such that said reaction continues autothermally.
11. The process of claim 4 comprising maintaining the temperature of said reactant gas mixture at least about 200°C prior to entry of said reactant gas stream into the reaction zone of said reactor.

12. The process of claim 4 wherein said O₂-containing gas is chosen from the group consisting of purified O₂, air, and O₂ enriched air.

13. The process of claim 4 wherein said reactor comprises a porous thermal shield disposed between said mixing zone and said reaction zone.

14. The process of claim 1 wherein said catalyst device comprises at least one structure chosen from the group consisting of gauzes, monoliths and a plurality of divided units.

15. The process of claim 14 wherein said divided units comprise particles, granules, beads, pills, pellets, cylinders, trilobes, extrudates or spheres.

16. The process of claim 1 wherein said catalyst device comprises at least one metal having activity for catalyzing the reaction $\text{H}_2\text{S} + 1/2 \text{O}_2 \rightarrow 1/x \text{S}_x + \text{H}_2\text{O}$ ($x = 2, 6 \text{ or } 8$).

17. The process of claim 16 wherein said catalyst device comprises at least one metal chosen from the group consisting of platinum, rhodium, ruthenium, iridium, nickel, palladium, iron, cobalt, rhenium and rubidium.

18. The process of claim 17 wherein said catalyst device comprises at least one metal chosen from the group consisting of platinum, rhodium, ruthenium, nickel, palladium and iridium

19. The process of claim 18 wherein said catalyst device comprises platinum, rhodium or a mixture thereof.

20. The process of claim 16 wherein said catalyst device comprises vanadium, bismuth or antimony.

21. The process of claim 16 wherein said catalyst device comprises at least one lanthanide element chosen from the group consisting of La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu.

22. The process of claim 21 wherein said lanthanide element is samarium, ytterbium or praseodymium.
23. The process of claim 14 wherein said structure comprises a refractory support.
24. The process of claim 23 wherein said catalyst device comprises zirconia, alpha-alumina or a metal oxide of a lanthanide.
25. The process of claim 23 wherein said catalyst device comprises platinum and a lanthanide metal oxide chosen from the group consisting of cerium oxide and lanthanum oxide.
26. The process of claim 23 wherein said catalyst device comprises rhodium and samarium oxide.
27. The process of claim 23 wherein said catalyst device comprises a platinum-rhodium alloy disposed on a lanthanide oxide coated refractory support.
28. The process of claim 27 wherein said catalyst device comprises samarium oxide.
29. The process of claim 16 wherein said catalyst device comprises at least one carbided metal.
30. The process of claim 29 wherein said at least one carbided metal comprises platinum and rhodium.
31. The process of claim 1 wherein said catalyst device comprises a sulfur resistant catalytic material prepared by a method comprising:
avoiding exposure of said catalytic material to a sulfur-containing compound at a temperature at which sulfur can chemically react with or physically deposit on said catalytic material, and

in the presence of a light hydrocarbon, heating said catalytic material to a temperature sufficient to cause at least a portion of said catalytic material to associate with carbon in the same chemical phase.

32. The process of claim 31 wherein said step of avoiding exposure of said catalytic material to a sulfur-containing compound includes avoiding exposure at a temperature below about 300°C-500°C.

33. The process of claim 32 wherein said step of heating said catalytic material in the presence of a light hydrocarbon includes mixing O₂ with said light hydrocarbon at a carbon:oxygen molar ratio not exceeding about 2:1.

34. The process of claim 32 wherein said step of heating said catalytic material in the presence of a light hydrocarbon includes heating the catalyst to at least 700°C.

35. The process of claim 31 wherein said method comprises carrying out said heating step before beginning to pass said H₂S-containing gas over said catalyst.

36. The process of claim 1 wherein said contact time is no more than about 200 milliseconds.

37. The process of claim 36 wherein said contact time is less than 50 milliseconds.

38. The process of claim 37 wherein said contact time is less than 20 milliseconds.

39. The process of claim 38 wherein said contact time is 10 milliseconds or less.

40. The process of claim 1 comprising operating said process at superatmospheric reactant gas pressure.